

WHAT IS CLAIMED IS:

1. A method of knurling a cylindrical surface of a workpiece, the workpiece having a longitudinal axis, the method comprising the steps of :
- 5 a) imparting a first plurality of grooves to a workpiece, wherein the first plurality of grooves has a first helix angle with respect to the longitudinal axis of the workpiece; wherein the first plurality of grooves includes a first groove and a second groove, the second groove being of substantially different configuration from the first groove; and
- 10 b) imparting a second plurality of grooves to the workpiece, wherein the second plurality of grooves has a second helix angle with respect to the longitudinal axis, the second plurality of grooves intersecting the first plurality of grooves, thereby imparting a knurl pattern to the outer surface of the workpiece.
- 15 2. The method of claim 1, wherein the second plurality of grooves includes a third groove and a fourth groove, the fourth groove being of substantially different configuration from the third groove.
- 20 3. The method of claim 1, wherein the first and second grooves each comprise a first groove surface, a second groove surface, and a groove base, wherein the first and second groove surfaces each extend from an outer surface of the workpiece to the groove base, and wherein the groove surfaces of the first groove are at a first included angle to one another, wherein the surfaces of the second groove are at a second included angle to one another, and wherein the second included angle is
- 25 substantially different from the first included angle.
4. The method of claim 3, wherein the first and second included angles differ by at least 3 degrees.
- 30 5. The method of claim 4, wherein the first and second included angles differ by at least 10 degrees.

6. The method of claim 2, wherein the third and fourth grooves each comprise a first groove surface, a second groove surface, and a groove base, wherein the first and second groove surfaces each extend from an outer surface of the workpiece to the groove base, and wherein groove surfaces of the third groove are at a third included angle to one another, wherein the surfaces of the fourth groove are at a fourth included angle to one another, and wherein the fourth included angle is substantially different from the third included angle.

7. The method of claim 6, wherein the third and fourth included angles differ by at least 3 degrees.

8. The method of claim 7, wherein the third and fourth included angles differ by at least 10 degrees.

9. The method of claim 3, wherein the groove base is a line formed at the juncture of the first and second groove surfaces.

10. The method of claim 1, wherein the intersection of the first plurality of grooves and second plurality of grooves thereby forms a plurality of pyramids on the outer surface of the workpiece, each of said pyramids including first opposed side surfaces formed by the first grooves and second opposed side surfaces formed by the second grooves, and wherein the plurality of pyramids includes a first pyramid and a second pyramid, the second pyramid being of substantially different configuration from the first pyramid.

11. The method of claim 10, wherein the opposed first sides of the first pyramid form a first angle therebetween, and wherein the opposed first surfaces of the second pyramid form a second angle therebetween, and wherein the second angle is at least 3 degrees different from the first angle.

12. The method of claim 11, wherein the second angle is at least 10 degrees different from the first angle.

13. The method of claim 10, wherein the pyramids are truncated pyramids.

14. The method of claim 1, wherein the pattern is continuous and uninterrupted around the circumference of the workpiece.

15. The method of claim 1, wherein the first and second groove helix angles are of substantially unequal magnitude.

16. A knurled workpiece made according to the method of claim 1.

17. A method of molding a molded article with a knurled workpiece according to claim 16, comprising the steps of:

- a) applying a moldable material to the outer surface of the workpiece;
- b) while the moldable material is in contact with the workpiece, applying sufficient force to the moldable material to impart the inverse of the pattern on the outer surface of the workpiece to a first surface of the moldable material in contact with the workpiece; and
- c) removing the moldable material from the workpiece.

18. A molded article made in accordance with the method of claim 17.

19. A knurled workpiece having a knurled, cylindrical outer surface, the knurled workpiece comprising:

a cylindrical body having a longitudinal axis and an outer cylindrical surface, said outer surface having a knurl pattern thereon;

wherein said knurl pattern comprises

a first plurality of grooves, said first plurality of grooves having a first helix angle with respect to said longitudinal axis of said

workpiece; said first plurality of grooves including a first groove and a second groove, said second groove being of a substantially different configuration from said first groove; and

a second plurality of grooves, said second plurality of grooves having a second helix angle with respect to said longitudinal axis, said second plurality of grooves intersecting said first plurality of grooves.

20. The knurled workpiece of claim 19, wherein said second plurality of grooves includes a third groove and a fourth groove, said fourth groove being of a substantially different configuration from said third groove.

21. The knurled workpiece of claim 19, wherein said first and second grooves each comprise a first groove surface, a second groove surface, and a groove base, wherein said first and second groove surfaces each extend from said workpiece outer surface to said groove base, and wherein said groove surfaces of said first groove are at a first included angle to one another and wherein said groove surfaces of said second groove are at a second included angle to one another, said second included angle being substantially different from said first included angle.

22. The knurled workpiece of claim 21, wherein said first and second included angles differ by at least 3 degrees.

23. The knurled workpiece of claim 21, wherein said first and second included angles differ by at least 10 degrees.

24. The knurled workpiece of claim 20, wherein said third and fourth grooves each comprise a first groove surface, a second groove surface, and a groove base, wherein said first and second groove surfaces each extend from said workpiece outer surface to said groove base, wherein said groove surfaces of said third groove are at a third included angle to one another and wherein said groove surfaces of said

fourth groove are at a fourth included angle to one another, said fourth included angle being substantially different from said third included angle.

25. The knurled workpiece of claim 24, wherein said third and fourth included
5 angles differ by at least 3 degrees.

26. The knurled workpiece of claim 24, wherein said third and fourth included
angles differ by at least 10 degrees.

10 27. The knurled workpiece of claim 21, wherein said groove base is a line
formed at the juncture of said first and second groove surfaces.

28. The knurled workpiece of claim 21, wherein the intersection of said
first plurality of grooves and said second plurality of grooves thereby forms a plurality
15 of pyramids on said workpiece outer surface, each of said pyramids including first
opposed side surfaces formed by said first grooves and second opposed side surfaces
formed by said second grooves, and wherein said plurality of pyramids includes a first
pyramid and a second pyramid, said second pyramid being of substantially different
configuration from said first pyramid.

20 29. The knurled workpiece of claim 28, wherein said opposed first sides of
said first pyramid form a first angle therebetween, and wherein said opposed first
surfaces of said second pyramid form a second angle therebetween, and wherein said
second angle is at least 3 degrees different from the first angle.

25 30. The knurled workpiece of claim 29, wherein said second angle is at
least 10 degrees different from said first angle.

31. The knurled workpiece of claim 29, wherein the pyramids are truncated
30 pyramids.

32. The knurled workpiece of claim 19, wherein said knurl pattern is continuous and uninterrupted around the circumference of said workpiece.

33. A method of molding a molded article with the knurled workpiece of claim 19, comprising the steps of:
- a) applying a moldable material to the outer surface of the knurled workpiece;
 - b) while the moldable material is in contact with the knurled workpiece, applying sufficient force to the moldable material to impart the inverse of the pattern on the outer surface of the knurled workpiece to a first surface of the moldable material in contact with the knurled workpiece; and
 - c) removing the moldable material from the knurled workpiece.

34. A molded article made in accordance with the method of claim 33.

35. An apparatus for holding a cutting knurl wheel, comprising:
- a main support body;
 - a shaft including a first end, a second end, and a longitudinal axis, wherein said shaft is rotatably mounted in said main body so as to rotate about said longitudinal axis;
 - a knurl wheel mount on the second end of said shaft;
 - a knurl wheel rotatably mounted on said knurl wheel mount so as to rotate about a knurl wheel axis, said knurl wheel including a plurality of teeth on an outer periphery thereof;
 - wherein said knurl wheel axis intersects said shaft longitudinal axis at an oblique angle;
 - whereby rotation of said knurl wheel about said knurl wheel axis defines a distal point that is the location furthest in the direction from said first end of said shaft to said second end of said shaft through which said knurl teeth pass, said distal point being on said shaft longitudinal axis; and

wherein said knurl wheel mount and knurl wheel are configured such that said distal point remains located on said shaft longitudinal axis during rotation of said shaft about said longitudinal axis.

5 36. An apparatus as in claim 35, wherein said shaft longitudinal axis and said knurl wheel axis intersect at an angle of from 80 to 87 degrees.

 37. A knurl wheel, comprising
 a body including first and second major opposed surfaces and an outer
10 peripheral surface between said first and second major surfaces; and
 a plurality of teeth on said outer peripheral surface, said plurality of teeth including a first tooth and a second tooth, said second tooth being of substantially different configuration from said first tooth.

15 38. The knurl wheel of claim 37, wherein said first tooth includes first and second sides extending from said outer peripheral surface, said first and second sides forming a first included angle therebetween, and wherein said second tooth includes third and fourth sides extending from said outer peripheral surface and defining a second included angle therebetween, said second angle being substantially different
20 from said first angle.

 39. The knurl wheel of claim 38, wherein said second angle differs from said first angle by at least 3 degrees.

25 40. The knurl wheel of claim 39, wherein said second angle differs from said first angle by at least 10 degrees.

 41. The knurl wheel of claim 37, wherein each of said plurality of teeth have a substantially different configuration.

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42. The knurl wheel of claim 37,
wherein each of said teeth includes a first side and a second side extending
from said outer peripheral surface;

wherein a respective first edge of one of said teeth and a respective second
5 edge of an adjacent one of said teeth form an included angle therebetween, thereby
forming a plurality of included angles between each adjacent pair of teeth; and

wherein a first one of said included angles is substantially different from a
second one of said included angles.

10 43. The knurl wheel of claim 42, wherein said first included angle differs
from said second included angle by at least 3 degrees.

44. The knurl wheel of claim 42, wherein said first included angle differs
from said second included angle by at least 10 degrees.

15 45. The knurl wheel of claim 42, wherein each of said included angles is
substantially different.